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(54) **COOLING CIRCUIT FOR A MULTI-WALL BLADE**

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F01D 5/18 (2006.01)
F02C 3/04 (2006.01)

(52) **U.S. Cl.**

CPC ***F01D 5/187*** (2013.01); ***F02C 3/04*** (2013.01); *F05D 2220/32* (2013.01); *F05D 2240/305* (2013.01); *F05D 2240/307* (2013.01); *F05D 2250/185* (2013.01); *F05D 2260/202* (2013.01)

(58) **Field of Classification Search**

CPC . F01D 5/186; F01D 5/187; F02C 3/04; F05D 2220/32; F05D 2240/305; F05D 2240/307; F05D 2250/185; F05D 2260/205

See application file for complete search history.

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(57) **ABSTRACT**

A cooling system according to an embodiment includes: a three-pass serpentine cooling circuit; and an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit; wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade.

20 Claims, 7 Drawing Sheets

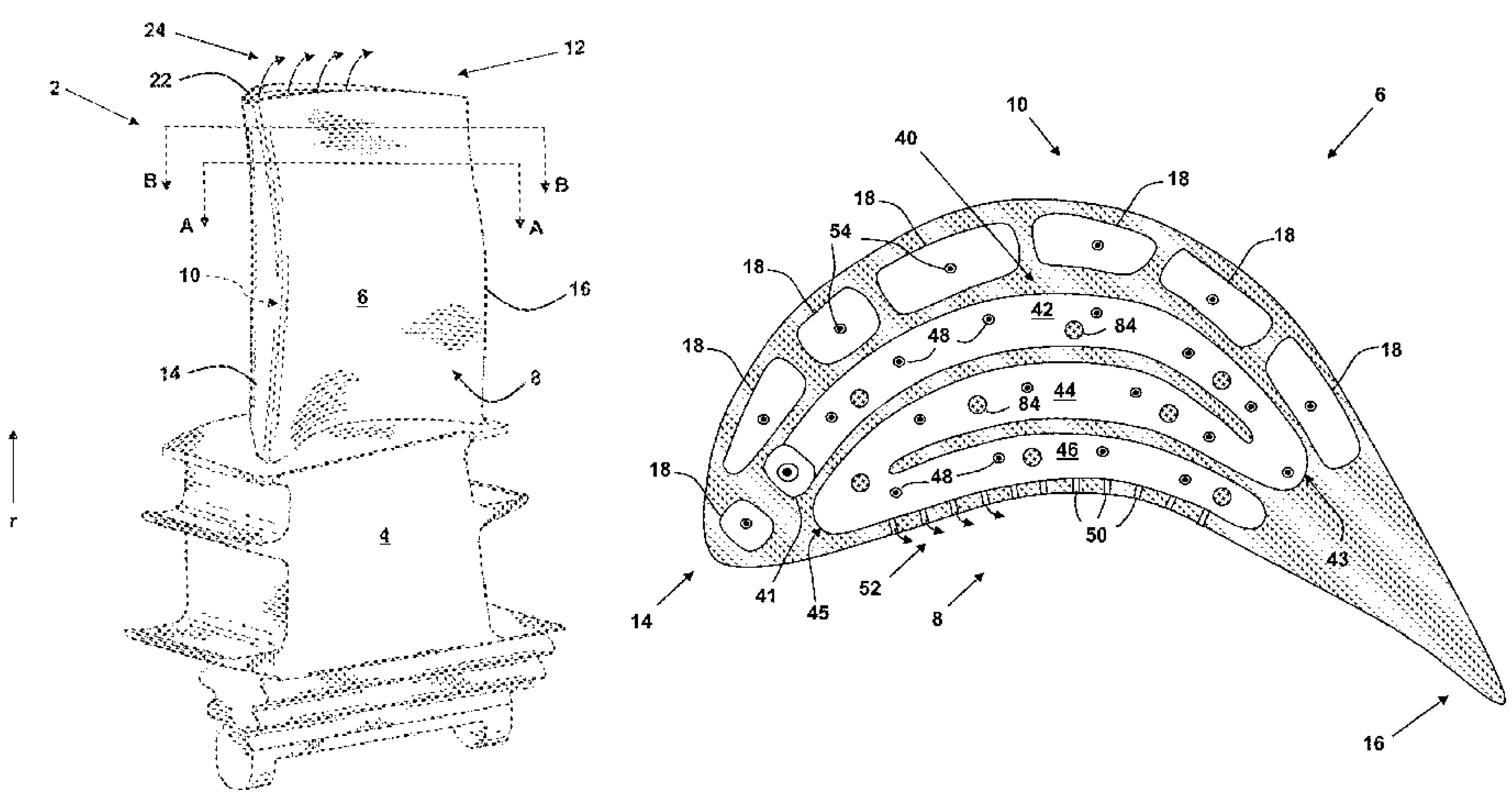

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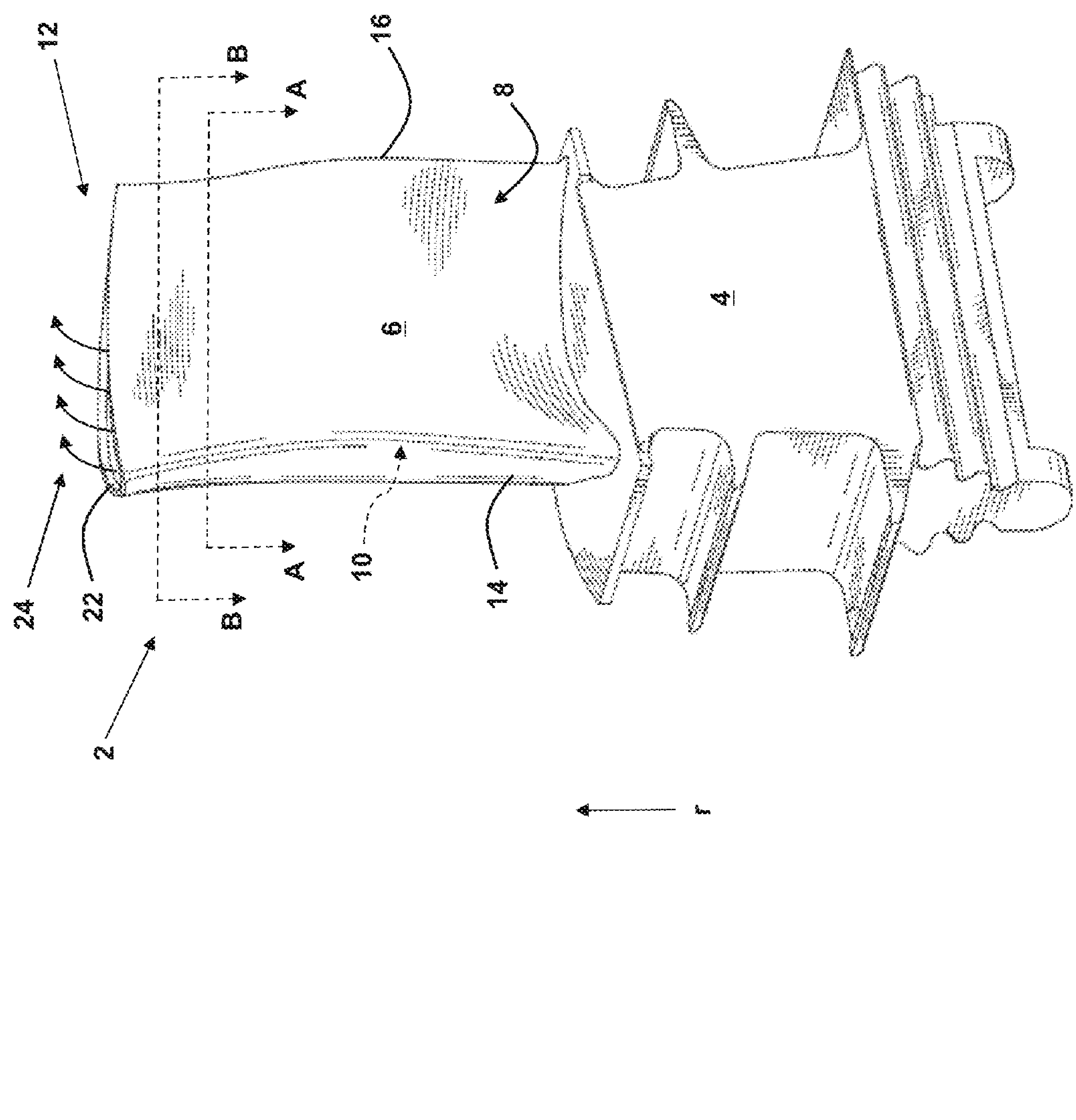
FIG. 1



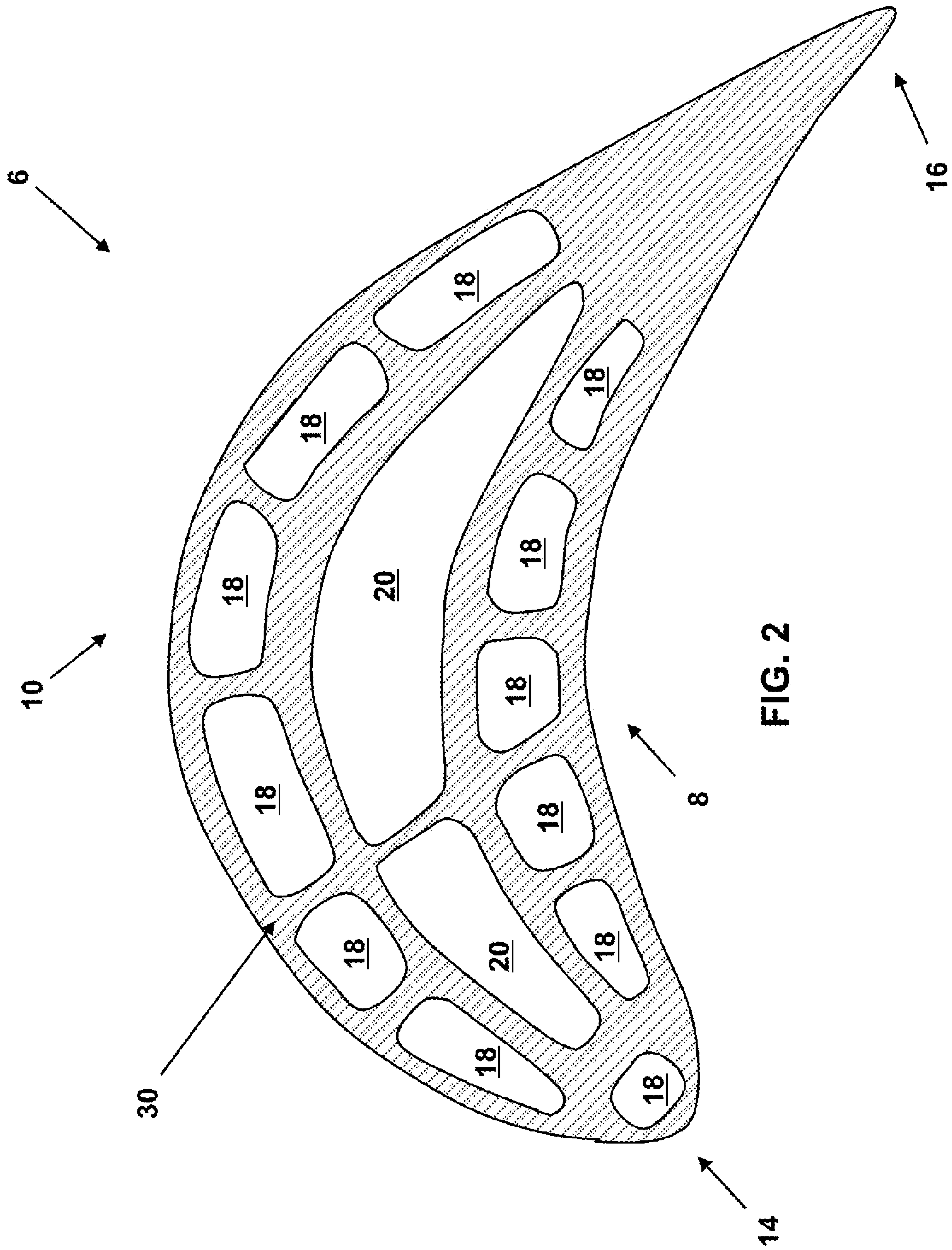
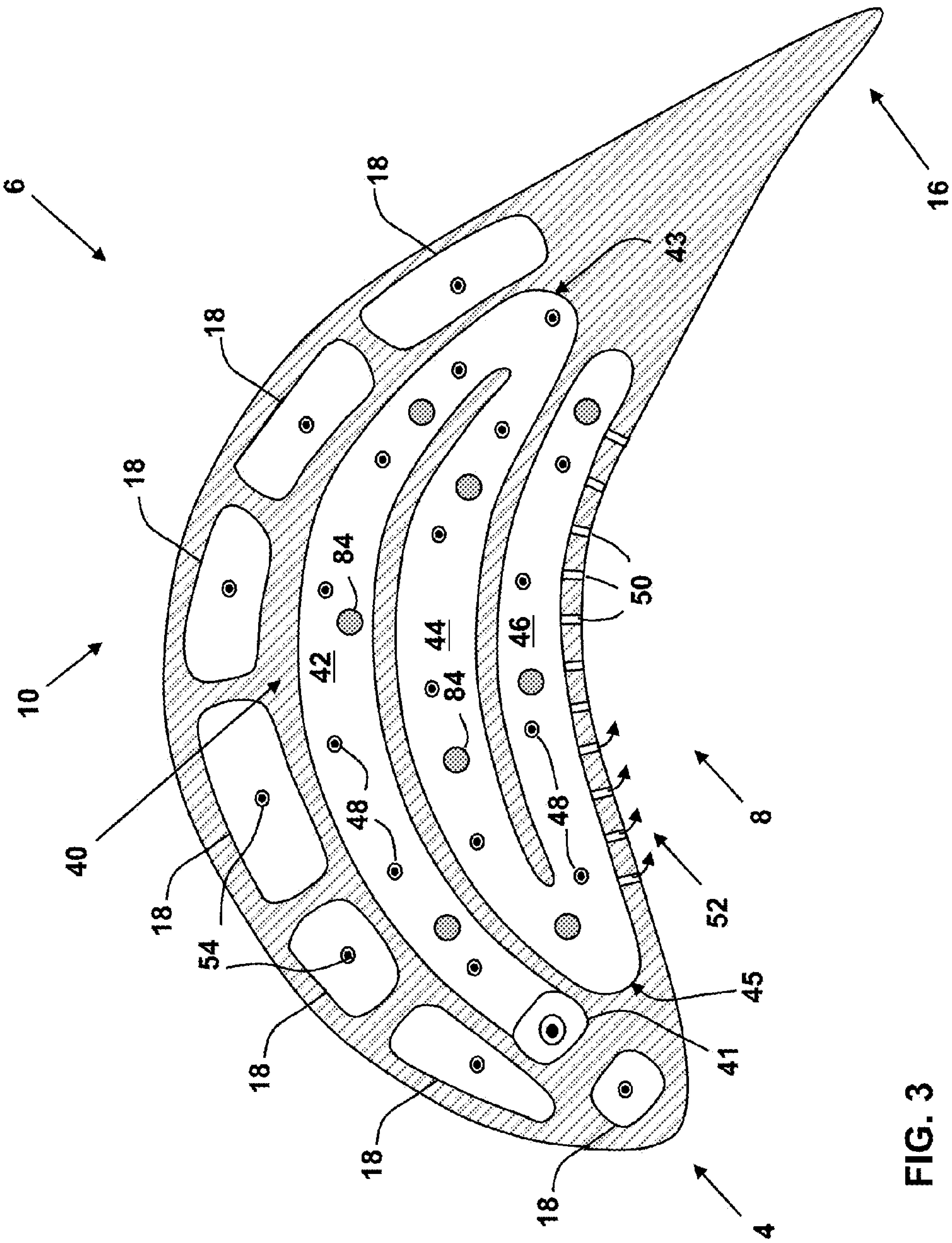


FIG. 2


6
10
16
18
18
18
18
54
18
18
18
43
40
42
44
46
84
84
48
48
48
50
52
8
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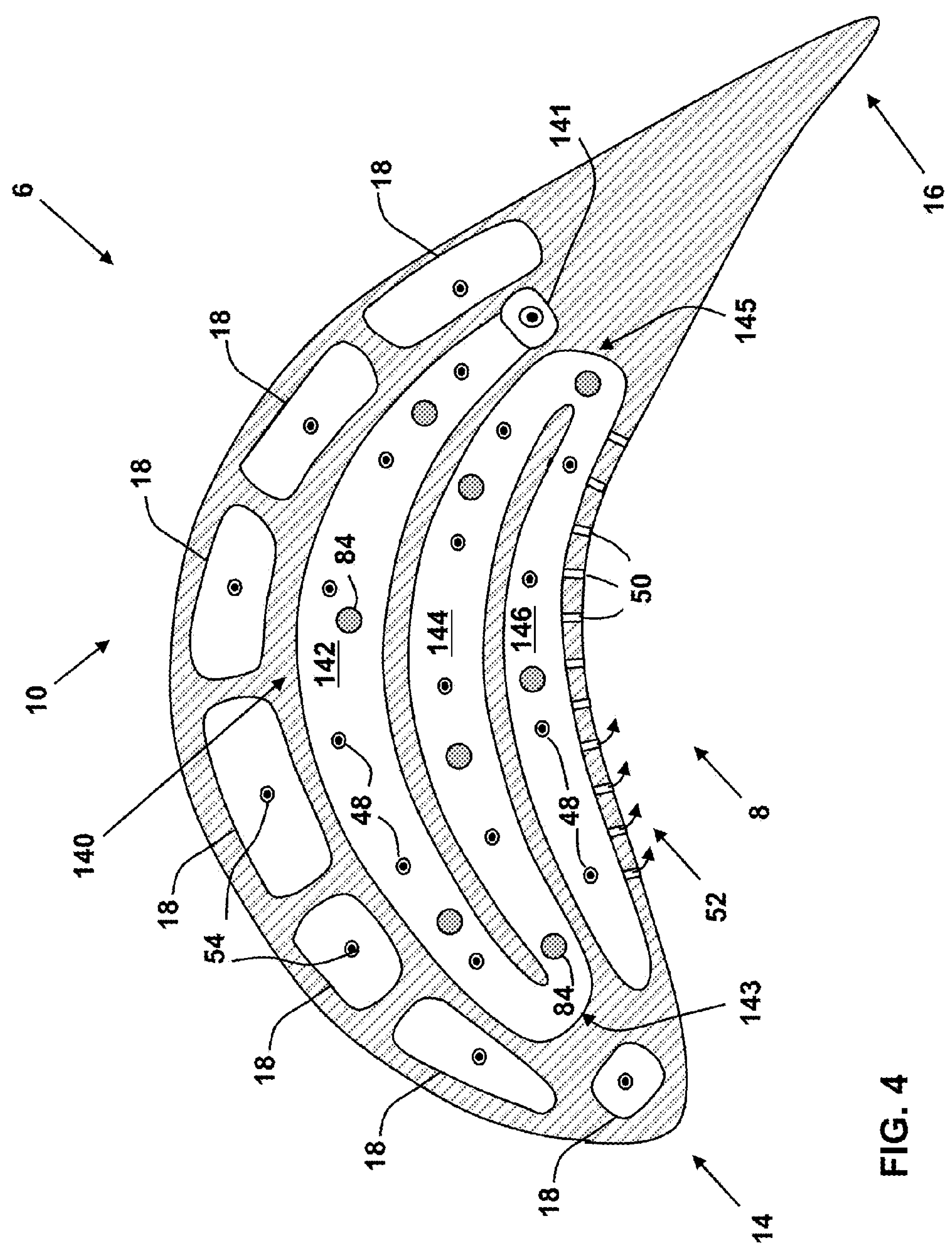
41
14

FIG. 3


6
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18
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141
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143
14

FIG. 4

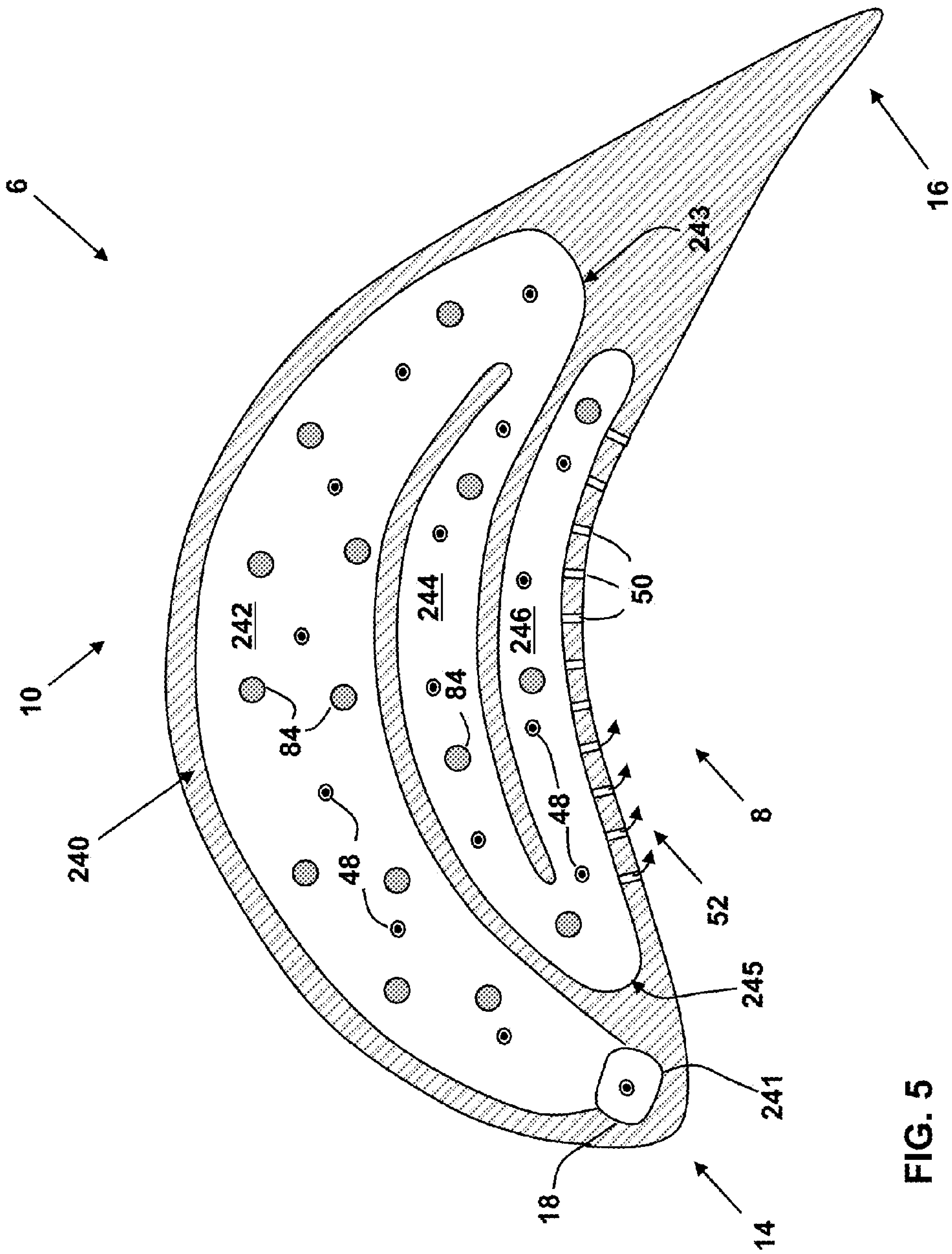

FIG. 5

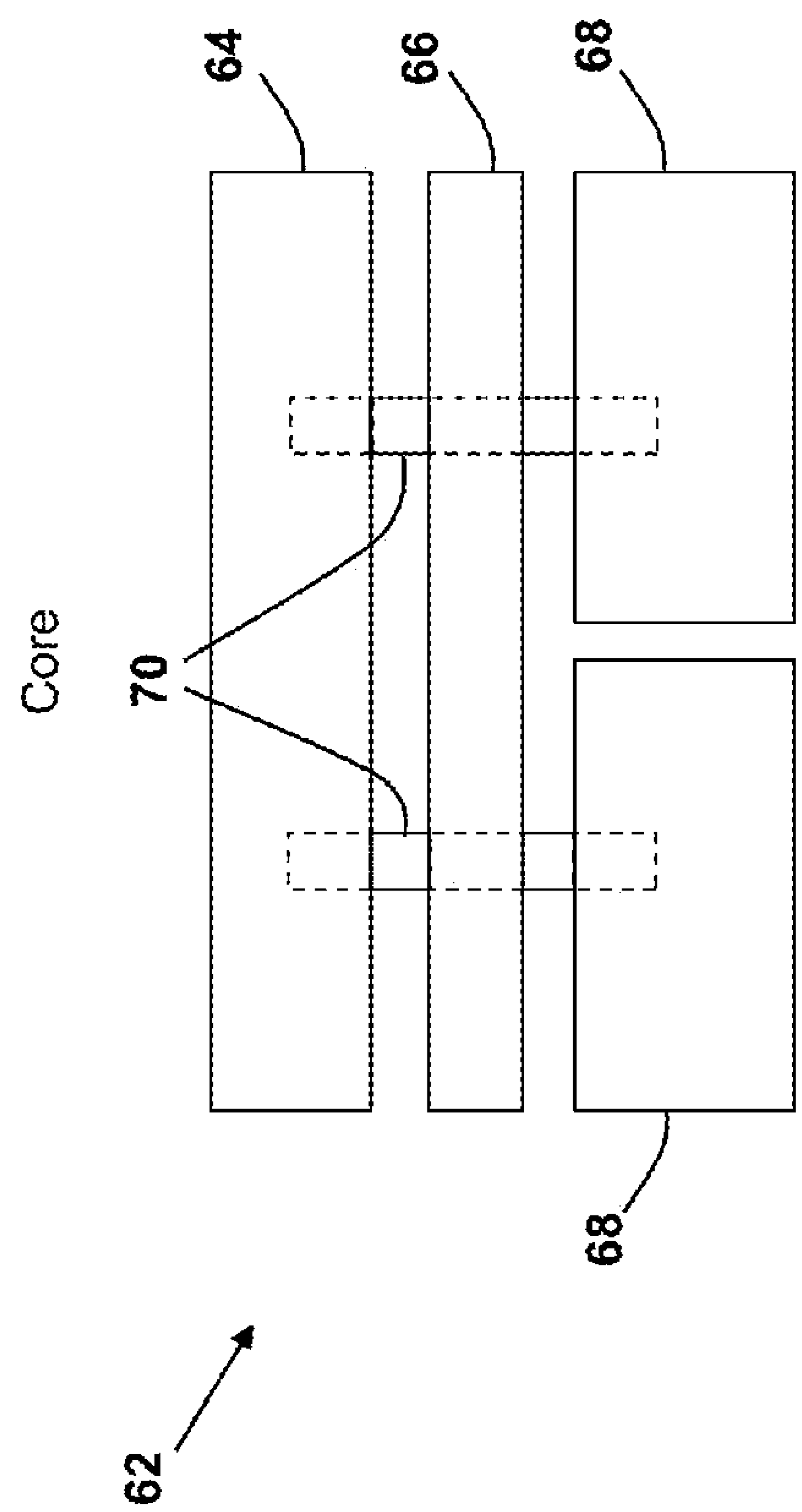

FIG. 6

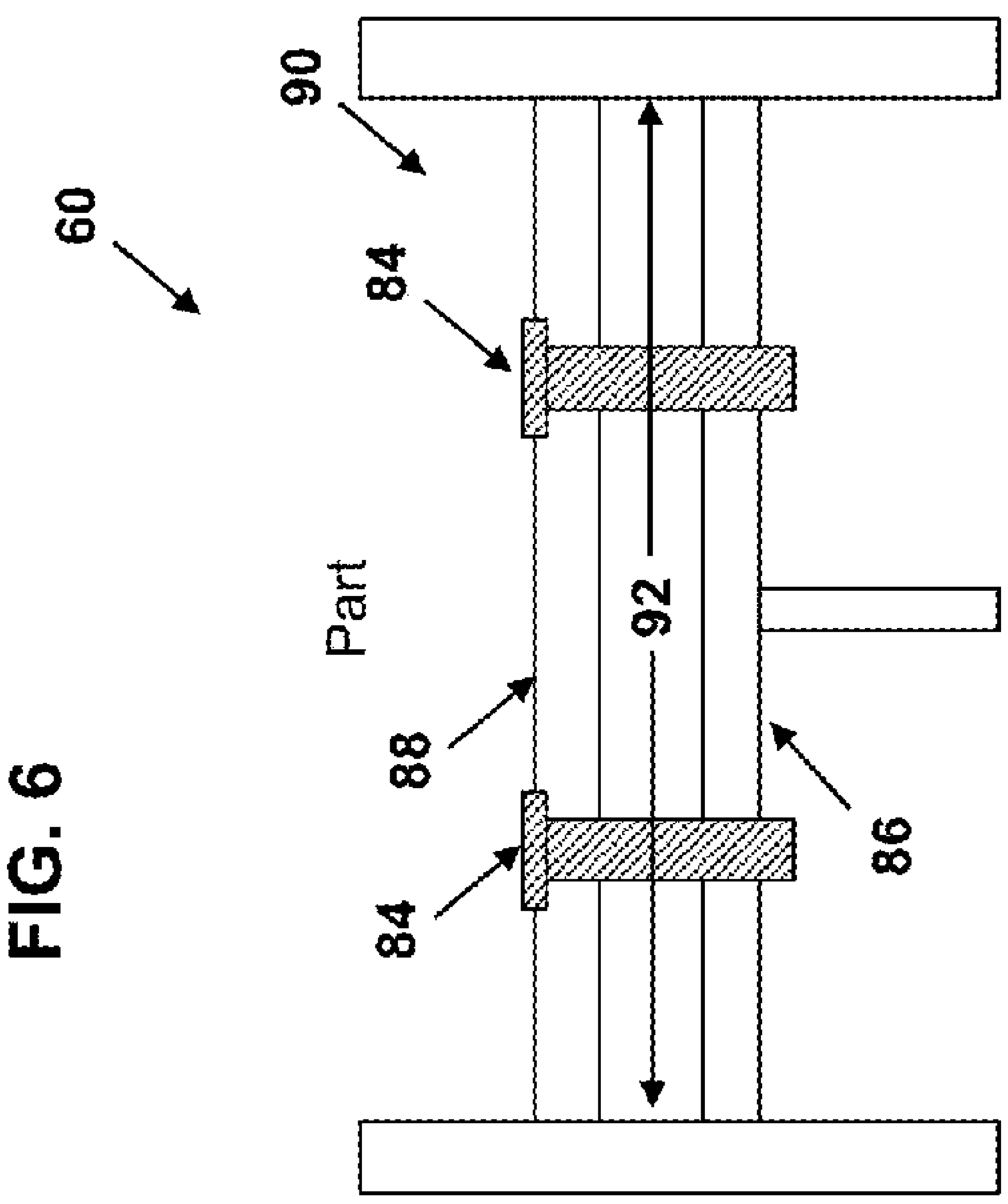

FIG. 8

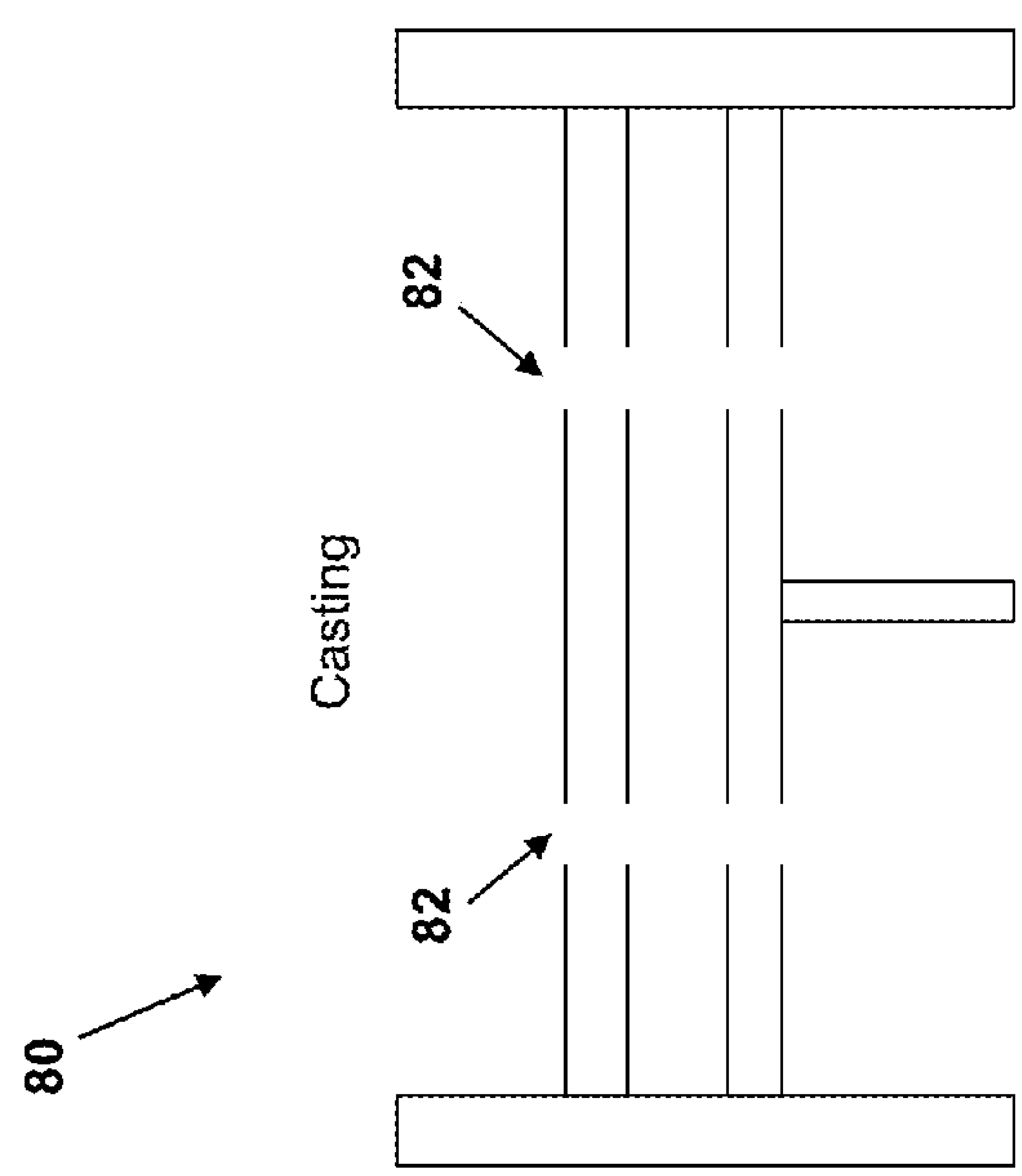

FIG. 7

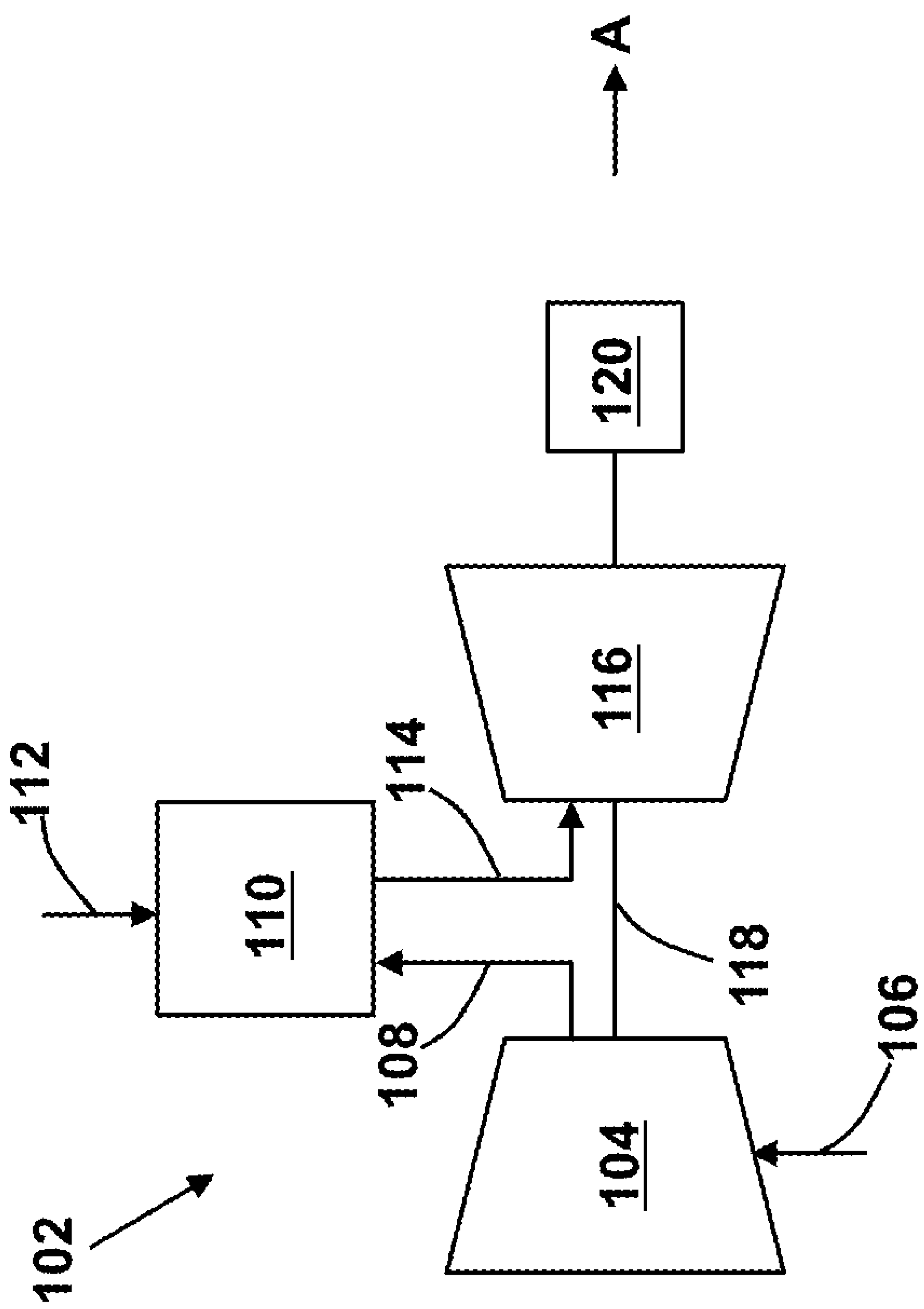

FIG. 9

COOLING CIRCUIT FOR A MULTI-WALL BLADE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to co-pending US applications, application Ser. No. 14/977,078, application Ser. No. 14/977,102, application Ser. No. 14/977,124, application Ser. No. 14/977,152, application Ser. No. 14/977,175, application Ser. No. 14/977,200, application Ser. No. 14/977,247, application Ser. No. 14/977,270, all filed on Dec. 21, 2015.

BACKGROUND OF THE INVENTION

The disclosure relates generally to turbine systems, and more particularly, to a cooling circuit for a tip area of a multi-wall blade.

Gas turbine systems are one example of turbomachines widely utilized in fields such as power generation. A conventional gas turbine system includes a compressor section, a combustor section, and a turbine section. During operation of a gas turbine system, various components in the system, such as turbine blades, are subjected to high temperature flows, which can cause the components to fail. Since higher temperature flows generally result in increased performance, efficiency, and power output of a gas turbine system, it is advantageous to cool the components that are subjected to high temperature flows to allow the gas turbine system to operate at increased temperatures.

Turbine blades typically contain an intricate maze of internal cooling channels. Cooling air provided by, for example, a compressor of a gas turbine system may be passed through the internal cooling channels to cool the turbine blades.

Multi-wall turbine blade cooling systems may include internal near wall cooling circuits. Such near wall cooling circuits may include, for example, near wall cooling channels adjacent the outside walls of a multi-wall blade. The near wall cooling channels are typically small, requiring less cooling flow, while still maintaining enough velocity for effective cooling to occur. Other, typically larger, low cooling effectiveness internal channels of a multi-wall blade may be used as a source of cooling air and may be used in one or more reuse circuits to collect and reroute "spent" cooling flow for redistribution to lower heat load regions of the multi-wall blade. At the tip of a multi-wall blade, the near wall cooling channels and low cooling effectiveness internal channels are exposed to very high heat loads.

BRIEF DESCRIPTION OF THE INVENTION

A first aspect of the disclosure provides a cooling system including: a three-pass serpentine cooling circuit; and an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit; wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade.

A second aspect of the disclosure provides a multi-wall turbine blade, including: a cooling system disposed within the multi-wall turbine blade, the cooling system including: a three-pass serpentine cooling circuit; and an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit; wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade.

A third aspect of the disclosure provides a turbomachine, including: a gas turbine system including a compressor component, a combustor component, and a turbine component, the turbine component including a plurality of turbine buckets, and wherein at least one of the turbine buckets includes a multi-wall blade; and a cooling system disposed within the multi-wall blade, the cooling system including: a three-pass serpentine cooling circuit; and an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit; wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade.

The illustrative aspects of the present disclosure solve the problems herein described and/or other problems not discussed.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of this disclosure will be more readily understood from the following detailed description of the various aspects of the disclosure taken in conjunction with the accompanying drawings that depict various embodiments of the disclosure.

FIG. **1** shows a perspective view of a turbine bucket including a multi-wall blade according to embodiments.

FIG. **2** is a cross-sectional view of the multi-wall blade of FIG. **1**, taken along line A-A in FIG. **1** according to various embodiments.

FIG. **3** is a cross-sectional view of a tip area of the multi-wall blade of FIG. **1**, taken along line B-B in FIG. **1** according to various embodiments.

FIG. **4** is a cross-sectional view of a tip area of the multi-wall blade of FIG. **1**, taken along line B-B in FIG. **1** according to various embodiments.

FIG. **5** is a cross-sectional view of a tip area of the multi-wall blade of FIG. **1**, taken along line B-B in FIG. **1** according to various embodiments.

FIGS. **6**-**8** depict an illustrative method for forming a portion of a three-pass serpentine cooling circuit according to various embodiments.

FIG. **9** is a schematic diagram of a gas turbine system according to various embodiments.

It is noted that the drawing of the disclosure is not to scale. The drawing is intended to depict only typical aspects of the disclosure, and therefore should not be considered as limiting the scope of the disclosure. In the drawing, like numbering represents like elements between the drawings.

DETAILED DESCRIPTION OF THE INVENTION

In the Figures, for example in FIG. **9**, the "A" axis represents an axial orientation. As used herein, the terms "axial" and/or "axially" refer to the relative position/direction of objects along axis A, which is substantially parallel with the axis of rotation of the turbomachine (in particular, the rotor section). As further used herein, the terms "radial" and/or "radially" refer to the relative position/direction of objects along an axis (r), which is substantially perpendicular with axis A and intersects axis A at only one location. Additionally, the terms "circumferential" and/or "circumferentially" refer to the relative position/direction of objects along a circumference (c) which surrounds axis A but does not intersect the axis A at any location.

As indicated above, the disclosure relates generally to turbine systems, and more particularly, to a cooling circuit for cooling a tip area of a multi-wall blade.

According to embodiments, the cooling circuit is configured to cool the tip area of a multi-wall blade of a gas turbine engine, while providing shielding to low cooling effectiveness internal channels and providing cooling film. Shielding may also be provided to high cooling effectiveness near wall cooling channels. The cooling circuit may include a three-pass serpentine cooling circuit, which may be fed with cooling air from a low cooling effectiveness internal channel or a near wall cooling channel. Air passes through the cooling circuit, providing convention cooling, and is exhausted as cooling film to cool the tip area of the multi-wall blade.

Turning to FIG. **1**, a perspective view of a turbine bucket **2** is shown. The turbine bucket **2** includes a shank **4** and a multi-wall blade **6** coupled to and extending radially outward from the shank **4**. The multi-wall blade **6** includes a pressure side **8**, an opposed suction side **10**, and a tip area **12**. The multi-wall blade **6** further includes a leading edge **14** between the pressure side **8** and the suction side **10**, as well as a trailing edge **16** between the pressure side **8** and the suction side **10** on a side opposing the leading edge **14**.

The shank **4** and multi-wall blade **6** may each be formed of one or more metals (e.g., steel, alloys of steel, etc.) and may be formed (e.g., cast, forged or otherwise machined) according to conventional approaches. The shank **4** and multi-wall blade **6** may be integrally formed (e.g., cast, forged, three-dimensionally printed, etc.), or may be formed as separate components which are subsequently joined (e.g., via welding, brazing, bonding or other coupling mechanism).

FIG. **2** is a cross-sectional view of the multi-wall blade **6** taken along line A-A of FIG. **1**. As shown, the multi-wall blade **6** may include, for example, an arrangement **30** of cooling channels including a plurality of high effectiveness near wall cooling channels **18** and one or more low cooling effectiveness internal channels **20**, hereafter referred to as "central plenums." Various cooling circuits can be provided using different combinations of the near wall cooling channels **18** and central plenums **20**.

An embodiment including a three-pass serpentine cooling circuit **40** is depicted in FIG. **3**, which is a cross-sectional view of the multi-wall blade **6** taken along line B-B of FIG. **1**. The three-pass serpentine cooling circuit **40** is located radially outward along the multi-wall blade **6** (e.g., closer to the tip area **12** of the multi-wall blade **6**) relative to the arrangement **30** of cooling channels shown in FIG. **2**. To this extent, comparing FIGS. **2** and **3**, the three-pass serpentine cooling circuit **40** effectively "shields" the central plenums **20** and at least some of the near wall cooling channels **18** from the very high heat loads that typically occur at the tip area **12** of the multi-wall blade **6** during rotation of the multi-wall blade **6** (e.g., in a gas turbine).

The three-pass serpentine cooling circuit **40** includes a first leg **42** and a second leg **44** that extend over and at least partially cover the central plenums **20**. The first leg **42** extends rearward from a forward air feed cavity **41** toward the trailing edge **16** of the multi-wall blade **6**. The second leg **44** extends forward from a turn **43** toward the leading edge **14** of the multi-wall blade **6**. The turn **43**, which is disposed adjacent the trailing edge **16** of the multi-wall blade **6**, fluidly couples the first and second legs **42**, **44** of the three-pass serpentine cooling circuit **40**. Although shown in FIG. **3** as extending over all of the central plenums **20**, the first and second legs **42** of the three-pass serpentine cooling circuit **40** may, in general, extend over one or more of the central plenums **20**.

The three-pass serpentine cooling circuit **40** further includes a third leg **46** that extends over a first set (e.g., one or more) of the near wall cooling channels **18** disposed adjacent the pressure side **8** of the multi-wall blade **6**. A turn **45** positioned adjacent the leading edge **14** of the multi-wall blade **6** fluidly couples the second and third second legs **44**, **46** of the three-pass serpentine cooling circuit **40**. The third leg **46** extends from the turn **45** toward the trailing edge **16** of the multi-wall blade **6**. Comparing FIGS. **2** and **3**, it can be seen that in this embodiment the third leg **46** extends over all of the near wall cooling channels **18** disposed adjacent the pressure side **8** of the multi-wall blade **6**. In general, however, the third leg **46** of the three-pass serpentine cooling circuit **40** may extend over one or more of the near wall cooling channels **18** disposed adjacent the pressure side **8** of the multi-wall blade **6**.

Cooling air is supplied to the first leg **42** of the three-pass serpentine cooling circuit **40** via the air feed cavity **41**. The air feed cavity **41** may be fluidly coupled to, and receive cooling air from, at least one of the central plenums **20**. In other embodiments, the air feed cavity **41** may be fluidly coupled to, and receive cooling air from, at least one of the near wall cooling channels **18**. In either case, in this embodiment, the air feed cavity **41** is disposed near the leading edge **14** of the multi-wall blade **6**.

In FIG. **3**, viewed in conjunction with FIGS. **1** and **2**, cooling air flows from the air feed cavity **41** (e.g., out of the page in FIG. **3**) into and through the first leg **42**, the turn **43**, the second leg **44**, the turn **45**, and the third leg **46**. In the first, second, and third legs **42**, **44**, **46** and the turns **43**, **45** of the three-pass serpentine cooling circuit **40**, the cooling air absorbs heat (e.g., via convention) from adjacent portions of the tip area **12** of the multi-wall blade **6**, shielding the underlying near wall cooling channels **18** and central plenums **20** from excessive heat. The cooling air flows out of at least one of the first, second, and third legs **42**, **44**, **46** (e.g., out the page in FIG. **3**) via at least one tip film channel **48**. Cooling air is directed by the tip film channels **48** to the tip **22** of the multi-wall blade **6**. The cooling air is exhausted from the tip **22** of the multi-wall blade **6** as tip film **24** to provide tip film cooling. In addition, cooling air is exhausted out of the third leg **46** to the pressure side **8** of the multi-wall blade **6** through at least one pressure side film channel **50** to provide film **52** for pressure side film cooling.

Cooling air may also be exhausted from at least one of the near wall cooling channels **18** to the tip **22** to provide tip film cooling. For example, as shown in FIG. **3**, at least one of the near wall cooling channels **18** may be fluidly coupled to the tip **22** of the multi-wall blade **6** by at least one tip film channel **54**. Cooling air is exhausted (out of the page in FIG. **3**) from the tip film channels **54** to provide tip film **24** for tip film cooling.

In another embodiment, an aft air feed cavity **141** disposed adjacent the trailing edge **16** of the multi-wall blade **6** may be used to supply cooling air to a three-pass serpentine cooling circuit **140**. Such a configuration is depicted in FIG. **4**, viewed in conjunction with FIGS. **1** and **2**.

The three-pass serpentine cooling circuit **140** includes a first leg **142** and a second leg **144** that extend over and at least partially cover the central plenums **20**. The first leg **142** extends forward from the aft air feed cavity **141** toward the leading edge **14** of the multi-wall blade **6**. The second leg **144** extends rearward from a turn **143** toward the trailing edge **16** of the multi-wall blade **6**. The turn **43**, which is disposed adjacent the leading edge **14** of the multi-wall blade **6**, fluidly couples the first and second legs **142**, **144** of the three-pass serpentine cooling circuit **140**.

The three-pass serpentine cooling circuit **140** further includes a third leg **146** that extends over a first set (e.g., one or more) of the near wall cooling channels **18** disposed adjacent the pressure side **8** of the multi-wall blade **6**. A turn **145** positioned adjacent the trailing edge **16** of the multi-wall blade **6** fluidly couples the second and third second legs **144**, **146** of the three-pass serpentine cooling circuit **140**. The third leg **146** extends from the turn **145** toward the leading edge **14** of the multi-wall blade **6**.

The air feed cavity **141** may be fluidly coupled to, and receive cooling air from, at least one of the central plenums **20** or at least one of the near wall cooling channels **18**. As with the embodiment shown in FIG. **3**, the three-pass serpentine cooling circuit **140** depicted in FIG. **4** is configured to shield the central plenums **20** and at least some of the pressure side near wall cooling channels **18** from the very high heat loads that typically occur at the tip area **12** of the multi-wall blade **6**. Further, the three-pass serpentine cooling circuit **140** depicted in FIG. **4** is configured to provide tip film **24** and pressure side film **52** for tip film cooling and pressure side film cooling, respectively.

In yet another embodiment, as depicted in FIG. **5**, viewed in conjunction with FIGS. **1** and **2**, a first leg **242** of a three-pass serpentine cooling circuit **240** may be enlarged to extend over and at least partially cover not only the central plenums **20** (e.g., as in FIG. **3**), but also a set (e.g., one or more) of the near wall cooling channels **18** disposed adjacent the suction side **10** of the multi-wall blade **6**.

As in the embodiment depicted in FIG. **3**, a second leg **244** of the three-pass serpentine cooling circuit **240** extends over and at least partially covers at least the central plenums **20**. The first leg **242** extends rearward from a forward air feed cavity **241** toward the trailing edge **16** of the multi-wall blade **6**. The second leg **244** extends forward from a turn **243** toward the leading edge **14** of the multi-wall blade **6**. The turn **243**, which is disposed adjacent the trailing edge **16** of the multi-wall blade **6**, fluidly couples the first and second legs **242**, **244** of the three-pass serpentine cooling circuit **240**.

The three-pass serpentine cooling circuit **240** further includes a third leg **246** that extends over a first set (e.g., one or more) of the near wall cooling channels **18** disposed adjacent the pressure side **8** of the multi-wall blade **6**. A turn **245** positioned adjacent the leading edge **14** of the multi-wall blade **6** fluidly couples the second and third second legs **244**, **246** of the three-pass serpentine cooling circuit **240**. The third leg **246** extends from the turn **245** toward the trailing edge **16** of the multi-wall blade **6**.

The air feed cavity **241** may be fluidly coupled to, and receive cooling air from, at least one of near wall cooling channels **18** or at least one of the central plenums **20**. The three-pass serpentine cooling circuit **240** depicted in FIG. **5** is configured to shield the central plenums **20**, at least some of the suction side near wall cooling channels **18**, and at least some of the pressure side near wall cooling channels **18** from the very high heat loads that typically occur at the tip area **12** of the multi-wall blade **6**. Further, similar to the embodiment shown in FIG. **3**, the three-pass serpentine cooling circuit **240** depicted in FIG. **5** is configured to provide tip film **24** and pressure side film **52** for tip film cooling and pressure side film cooling, respectively.

In FIG. **5**, the air feed cavity **241** is disposed near the leading edge **14** of the multi-wall blade **6**, with the first leg **242** of the three-pass serpentine cooling circuit **240** extending toward the trailing edge **16** of the multi-wall blade **6**. However, similar to the embodiment shown in FIG. **4**, the air feed cavity **241** may be disposed near the trailing edge **16** of the multi-wall blade **6**, with the first leg **242** of the three-pass serpentine cooling circuit **240** extending toward the leading edge **14** of the multi-wall blade **6**.

FIGS. **6-8** depict an illustrative method for forming a portion **60** of the three-pass serpentine cooling circuit **40** (FIG. **3**) according to an embodiment. A cross-sectional view of a core **62** (e.g., a ceramic core) for use in a process for casting the portion **60** of the three-pass serpentine cooling circuit **40** is shown in FIG. **6**.

The core **62** includes a squealer core section **64**, a tip core section **66**, and at least one body core section **68**. Support rods **70** secure and separate the various core sections **64**, **66**, **68**. The squealer core section **64** will form, after casting, a cavity at the tip **22** of the multi-wall blade **6** that is radially open to the outside. The tip core section **66** will form, after casting, one of the legs **42**, **46** of the three-pass serpentine cooling circuit **40**. The body core section **68** will form, after casting at least one of the near wall cooling channels **18** or central plenums **20**.

An example of a metal casting **80** produced using the core **62** (e.g., using known casting techniques) is depicted in FIG. **7**. The casting **80** includes a plurality of openings **82** corresponding to the locations of the support rods **70** in the core **62**. According to an embodiment, as shown in FIG. **8**, each opening **82** may be sealed using a metal (e.g., braze material) plug **84**. The plug **84** can, for example, be inserted into an opening **82**, press-fit or otherwise inserted into an intra-cavity rib **86** of the casting **80**, and secured (e.g., via brazing) to the floor **88** of the squealer cavity **90** and the intra-cavity rib **86**. To this extent, the plugs **84** extend completely through the opening **92** between the intra-cavity rib **86** and the floor **88** of the squealer cavity **90**, preventing cooling air from leaking out of the opening **92** through the openings **82**.

The opening **92** between the intra-cavity rib **86** and the floor **88** of the squealer cavity **90** may be used, for example, to provide one of the legs **42**, **46** of the three-pass serpentine cooling circuit **40**, with the plugs **84** oriented substantially perpendicular to the flow of cooling air (e.g., into or out of the page in FIG. **8**) through the opening **92**. In this position, the plugs **84** not only seal the openings **82** on opposing sides of the opening **92**, but also serve as cooling pins, increasing the cooling effectiveness of the three-pass serpentine cooling circuit **40** by improving convective heat flow and promoting turbulent air flow. Possible locations of the plugs **84** in the first and second legs **42**, **46** of the three-pass serpentine cooling circuit **40** are shown in FIGS. **3-5**. The depicted locations of the plugs **84** in FIGS. **3-5** are for illustration only and are not meant to be limiting.

FIG. **9** shows a schematic view of gas turbomachine **102** as may be used herein. The gas turbomachine **102** may include a compressor **104**. The compressor **104** compresses an incoming flow of air **106**. The compressor **104** delivers a flow of compressed air **108** to a combustor **110**. The combustor **110** mixes the flow of compressed air **108** with a pressurized flow of fuel **112** and ignites the mixture to create a flow of combustion gases **114**. Although only a single combustor **110** is shown, the gas turbomachine **102** may include any number of combustors **110**. The flow of combustion gases **114** is in turn delivered to a turbine **116**, which typically includes a plurality of turbine buckets **2** (FIG. **1**). The flow of combustion gases **114** drives the turbine **116** to produce mechanical work. The mechanical work produced in the turbine **116** drives the compressor **104** via a shaft **118**, and may be used to drive an external load **120**, such as an electrical generator and/or the like.

In various embodiments, components described as being “coupled” to one another can be joined along one or more interfaces. In some embodiments, these interfaces can include junctions between distinct components, and in other cases, these interfaces can include a solidly and/or integrally formed interconnection. That is, in some cases, components that are “coupled” to one another can be simultaneously formed to define a single continuous member. However, in other embodiments, these coupled components can be formed as separate members and be subsequently joined through known processes (e.g., fastening, ultrasonic welding, bonding).

When an element or layer is referred to as being “on”, “engaged to”, “connected to” or “coupled to” another element, it may be directly on, engaged, connected or coupled to the other element, or intervening elements may be present. In contrast, when an element is referred to as being “directly on,” “directly engaged to”, “directly connected to” or “directly coupled to” another element, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., “between” versus “directly between,” “adjacent” versus “directly adjacent,” etc.). As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosure. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A cooling system, comprising:

a three-pass serpentine cooling circuit; and

an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit;

wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade; wherein the three-pass serpentine circuit runs substantially perpendicular to the radial direction.

2. The cooling system of claim **1**, wherein the first set of near wall cooling channels is located adjacent a pressure side of the multi-wall blade.

3. The cooling system of claim **2**, wherein the three-pass serpentine cooling circuit extends over and at least partially covers a second set of near wall cooling channels in the multi-wall blade.

4. The cooling system of claim **3**, wherein the second set of near wall cooling channels is located adjacent a suction side of the multi-wall blade.

5. The cooling system of claim **1**, wherein at least one leg of the three-pass serpentine cooling circuit includes at least one tip film channel for directing the cooling air to a tip of the multi-wall blade to provide tip film.

6. The cooling system of claim **1**, wherein at least one leg of the three-pass serpentine cooling circuit includes at least one pressure side film channel for directing the cooling air to a pressure side of the multi-wall blade to provide pressure side film.

7. The cooling system of claim **1**, wherein the cooling air is supplied to the air feed cavity from a central plenum or a near wall cooling channel of the multi-wall blade.

8. A multi-wall turbine blade, comprising:

a cooling system disposed within the multi-wall turbine blade, the cooling system including:

a three-pass serpentine cooling circuit; and

an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit;

wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade; wherein the three-pass serpentine circuit runs substantially perpendicular to the radial direction.

9. The multi-wall turbine blade of claim **8**, wherein the first set of near wall cooling channels is located adjacent a pressure side of the multi-wall blade.

10. The multi-wall turbine blade of claim **9**, wherein the three-pass serpentine cooling circuit extends over and at least partially covers a second set of near wall cooling channels in the multi-wall blade.

11. The multi-wall turbine blade of claim **10**, wherein the second set of near wall cooling channels is located adjacent a suction side of the multi-wall blade.

12. The multi-wall turbine blade of claim **8**, wherein at least one leg of the three-pass serpentine cooling circuit includes at least one tip film channel for directing the cooling air to a tip of the multi-wall blade to provide tip film.

13. The multi-wall turbine blade of claim **8**, wherein at least one leg of the three-pass serpentine cooling circuit includes at least one pressure side film channel for directing the cooling air to a pressure side of the multi-wall blade to provide pressure side film.

14. The multi-wall turbine blade of claim **8**, wherein the cooling air is supplied to the air feed cavity from a central plenum or a near wall cooling channel of the multi-wall blade.

15. A turbomachine, comprising:

a gas turbine system including a compressor component, a combustor component, and a turbine component, the turbine component including a plurality of turbine buckets, and wherein at least one of the turbine buckets includes a multi-wall blade; and

a cooling system disposed within the multi-wall blade, the cooling system including:

a three-pass serpentine cooling circuit; and

an air feed cavity for supplying cooling air to the three-pass serpentine cooling circuit;

wherein the three-pass serpentine cooling circuit extends radially outward from and at least partially covers at least one central plenum and a first set of near wall cooling channels of a multi-wall blade; wherein the three-pass serpentine circuit runs substantially perpendicular to the radial direction.

16. The turbomachine of claim **15**, wherein the first set of near wall cooling channels is located adjacent a pressure side of the multi-wall blade.

17. The turbomachine of claim **16**, wherein the three-pass serpentine cooling circuit extends over and at least partially covers a second set of near wall cooling channels in the multi-wall blade, wherein the second set of near wall cooling channels is located adjacent a suction side of the multi-wall blade.

18. The turbomachine of claim **1**, wherein at least one leg of the three-pass serpentine cooling circuit includes at least one tip film channel for directing the cooling air to a tip of the multi-wall blade to provide tip film.

19. The turbomachine of claim **1**, wherein at least one leg of the three-pass serpentine cooling circuit includes at least one pressure side film channel for directing the cooling air to a pressure side of the multi-wall blade to provide pressure side film.

20. The turbomachine of claim **1**, wherein the cooling air is supplied to the air feed cavity from a central plenum or a near wall cooling channel of the multi-wall blade.

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